CLAIMS

What is claimed is:

1. A positive electrode for a rechargeable lithium battery, comprising:

a current collector;

a positive active material layer coated on said current collector, said positive active material layer comprising a positive active material; and

a surface-treatment layer on said positive active material layer, said surface treatment layer comprising a compound selected from the group consisting of a coating-element-included hydroxide, a coating-element-included oxyhydroxide, a coating-element-included oxycarbonate, a coating-element-included hydroxycarbonate, and a mixture thereof.

2. The positive electrode according to claim 1, wherein said positive active material comprises a lithiated compound selected from the group consisting of compounds represented by the formulas 1 to 13:

$Li_xMn_{1-y}M_yA_2$ (1)

$Li_xMn_{1-y}M_yO_{2-z}X_z$ (2)

$Li_xMn_2O_{4-z}X_z$ (3)

$Li_xMn_{2-y}M_yA_4$ (4)

$Li_xCo_{1-y}M_yA_2$ (5)

$Li_xCo_{1-y}M_yO_{2-z}X_z$ (6)

$Li_xNi_{1-y}M_yA_2$ (7)

$Li_xNi_{1-y}M_yO_{2-z}X_z$ (8)

$Li_xNi_{1-y}Co_yO_{2-z}X_z$ (9)

$Li_xNi_{1-y-z}Co_yM_zA_\alpha$ (10)

$Li_xNi_{1-y-z}Co_yM_zO_{2-\alpha}X_\alpha$ (11)

$Li_xNi_{1-y-z}Mn_yM_zA_\alpha$ (12)

$Li_xNi_{1-y-z}Mn_yM_zO_{2-\alpha}X_\alpha$ (13)

wherein:

$0.95 \leq x \leq 1.1$; $0 \leq y \leq 0.5$; $0 \leq z \leq 0.5$; $0 \leq \alpha \leq 2$,

M is one element selected from the group consisting of Al, Ni, Co, Mn, Cr, Fe, Mg, Sr, V, and rare earth elements,

A is selected from the group consisting of O, F, S, and P, and

X is selected from the group consisting of F, S, and P.

3. The positive electrode according to claim 1, wherein said surface-treatment layer comprises a coating-element selected from the group consisting of Mg, Al, Co, K, Na, Ca, Si, Ti, Sn, V, Ge, Ga, B, As, and Zr.

4. The positive electrode according to claim 1, wherein said surface-treatment layer is formed by coating the positive active material layer with a coating liquid.

5. The positive electrode according to claim 4, wherein the coating process includes one of a dipping method and a vacuum impregnation method.

6. A method of preparing a positive electrode for a rechargeable lithium battery, comprising:

treating a current collector, which is coated with a layer of a positive active material, with a coating liquid, the coating liquid comprising one of a coating element and a coating-element-included compound; and

drying the treated current collector to form a surface treatment layer comprising one of a coating-element-included hydroxide, a coating-element-included oxyhydroxide, a coating-element-included oxycarbonate, a coating-element-included hydroxycarbonate, and a mixture thereof.

7. The method according to claim 6, wherein the positive active material comprises a lithiated compound selected from the group consisting of compounds represented by the formulas 1 to 13:

$Li_xMn_{1-y}M_yA_2$ (1)

$Li_xMn_{1-y}M_yO_{2-z}X_z$ (2)

$Li_xMn_2O_{4-z}X_z$ (3)

$Li_xMn_{2-y}M_yA_4$ (4)

$Li_xCo_{1-y}M_yA_2$ (5)

$Li_xCo_{1-y}M_yO_{2-z}X_z$ (6)

$Li_xNi_{1-y}M_yA_2$ (7)

$Li_xNi_{1-y}M_yO_{2-z}X_z$ (8)

$Li_xNi_{1-y}Co_yO_{2-z}X_z$ (9)

$Li_xNi_{1-y-z}Co_yM_zA_\alpha$ (10)

$Li_xNi_{1-y-z}Co_yM_zO_{2-\alpha}X_\alpha$ (11)

$Li_xNi_{1-y-z}Mn_yM_zA_\alpha$ (12)

$Li_xNi_{1-y-z}Mn_yM_zO_{2-\alpha}X_\alpha$ (13)

wherein:

$0.95 \le x \le 1.1$; $0 \le y \le 0.5$; $0 \le z \le 0.5$; $0 \le \alpha \le 2$,

M is one element selected from the group consisting of Al, Ni, Co, Mn, Cr, Fe, Mg, Sr, V, and rare earth elements,

A is selected from the group consisting of O, F, S, and P, and

X is selected from the group consisting of F, S, and P.

8. The method of claim 6, wherein said drying the treated current collector comprises drying the treated current collector to form one of an amorphous and a crystalline surface treatment layer.

9. The method according to claim 6, wherein a concentration of the coating element in the coating liquid at or between 0.1 and 50%.

10. The method according to claim 6, wherein said treating the current collector comprises dipping or vacuum-impregnating the current collector in the coating liquid.

11. The method of claim 6, wherein the coating element comprises one of Mg, Al, Co, K, Na, Ca, Si, Ti, V, Sn, Ge, B, As, and Zr.

12. The method of claim 11, wherein a concentration of the coating element in the coating element liquid is at or between 0.1% and 20 wt% of the coating liquid.

13. The method of claim 12, wherein said treating the current collector comprises coating the current collector to form a surface treatment layer having a thickness at or between 1 and 100 nm.

14. The method of claim 6, wherein said treating the current collector comprises:

immersing the current collector in the coating liquid to form a surface treatment layer having a thickness at or between 1 and 100 nm, and

removing the current collector from the coating liquid to be dried.

15. The method of claim 6, wherein said treating the current collector comprises inserting the current collector coated with the coating liquid in a reduced pressure environment in order to impregnate the coating liquid in pores of positive active material layer to form a surface treatment layer having a thickness at or between 1 and 100 nm.

16. The method of claim 6, wherein said drying comprises drying at a temperature at or between 20°C and 200°C for at or between 1 to 20 hours.

17. A method of preparing a positive electrode for a rechargeable lithium battery, comprising:

coating a current collector with a positive active material composition to form a positive active material layer, the positive active material composition comprising a positive active material selected from the group consisting of lithium chalcogenide, lithium-cobalt chalcogenide, lithium-manganese chalcogenide, lithium-nickel chalcogenide and lithium-nickel-manganese chalcogenide;

dipping the current collector having the positive active material layer in a coating liquid, the coating liquid comprising one of Al and B; and

drying the treated current collector.

18. The method according to claim 17, wherein a concentration of the coating liquid is at or between 0.1 and 50%.

19. The method according to claim 17, wherein said drying the treated current collector is performed at a temperature at or between room ambient temperature and 200°C for 1 to 20 hours.

20. A method of preparing a positive electrode for a rechargeable lithium battery, comprising:

coating a current collector with a positive active material composition to form a positive active material layer, the positive active material composition comprising a $LiCoO_2$ positive active material;

dipping the current collector having the positive active material layer in a coating liquid, the coating liquid comprising one of Al and B; and

drying the treated current collector.

21. The method according to claim 20, wherein the concentration of the coating liquid is at or between 0.1 and 50%.

22. The method according to claim 20, wherein said drying the treated current collector is performed at or between room ambient temperature and 200°C for at or between 1 and 20 hours.

23. A positive electrode for a rechargeable lithium battery, comprising:

a current collector;

a positive active material layer coated on said current collector, said positive active material layer comprising a positive active material selected from the group consisting of lithium-cobalt chalcogenide, lithium-manganese chalcogenide, lithium-nickel chalcogenide and lithium-nickel-manganese chalcogenide; and

a surface-treatment layer on said positive active material layer, said surface treatment layer comprising a compound selected from the group consisting of a coating-element-included hydroxide, a coating-element-included oxyhydroxide, a coating-element-included oxycarbonate, a coating-element-included hydroxycarbonate, and a mixture thereof,

wherein the coating-element is one of Al and B.

24. A positive electrode for a rechargeable lithium battery, comprising:

a current collector;

a positive active material layer coated on said current collector, said positive active material layer comprising a $LiCoO_2$ positive active material; and

a surface-treatment layer disposed on said positive active material layer, said surface treatment layer comprising a compound selected from the group consisting of a coating-element-included hydroxide, a coating-element-included oxyhydroxide, a coating-element-included oxycarbonate, a coating-element-included hydroxycarbonate, and a mixture thereof,

wherein the coating-element is one of Al and B.

25. A lithium battery comprising:

a first electrode comprising a layer of a lithiated compound coated with a surface treatment layer, the surface treatment layer comprising one of a coating-element-included hydroxide, a coating-element-included oxyhydroxide, a coating-element-included oxycarbonate, a coating-element-included hydroxycarbonate, and a mixture thereof;

a second electrode comprising a material to reversibly intercalate lithium ions; and

a separator and an electrolyte disposed between said first and second electrodes.

26. The lithium battery of claim 25, wherein the coating element comprises one of Mg, Al, Co, K, Na, Ca, Si, Ti, V, Sn, Ge, B, As, and Zr.

27. The lithium battery of claim 25, wherein the surface treatment layer has a thickness of at or between 1 and 100 nm.

28. The lithium battery of claim 25, wherein said first electrode is prepared in accordance with a method comprising:

treating a current collector, which is coated with a layer of a positive active material, with a coating liquid, the coating liquid comprising one of a coating element and a coating-element-included compound; and

drying the treated current collector to form the surface treatment layer comprising one of the coating-element-included hydroxide, the coating-element-included oxyhydroxide, the coating-element-included oxycarbonate, the coating-element-included hydroxycarbonate, and a mixture thereof.